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**The surgeon's view: digital video recording in veterinary surgery using a commercially available head camera**

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**Abstract**
We describe a practical recording method with a commercially head-mounted video camera[a] for video- and photo-recording of clinical procedures. We used a head camera[a]. This is one of the smallest video cameras available to record outdoor activities and is fairly reasonably priced. To best describe its possible uses and advantages, we recorded seven different surgical cases and procedures, both in hospital and in field settings. In all seven cases, the head camera[a] produced high-quality photographs and videos, with a good point of view, and allowed to reduce the number of people on the surgical field. Video-and photo-recording is useful for a number of reasons, including legal, educational, and archiving purposes. The head camera[a] that we have tested it is an effective, easy-to-use tool for recording surgeries and various veterinary procedures in all situations, with no need for assistance from a dedicated operator. For the above reasons, we believe it can be a valuable aid for veterinarians working in all fields of the profession.

**Introduction**
Video- and photo-recording of surgical procedures is of great importance today. Cameras are employed to document lesions, to record surgical and hospital procedures, as a training aid for students, for personal use, and also occasionally for legal purposes. Pictures and videos have come centre-stage in conference settings, or in the description of new surgical techniques and are regularly allotted online content-space in many scientific journals.
In recent years, a number of recording systems in open surgery have been described, with excellent results in terms of quality and exposure of the surgical field[1-3] . Nevertheless, existing equipment requires a table-mounted holder, which in turns implies a considerable loss of time for preparation, or a dedicated camera operator. Not all veterinary hospitals, however, provide a recording service, while in field conditions the presence of an extra person may prove very difficult or even impossible to organise. On a related note, the cost of a dedicated medical recording system can be unaffordable for practitioners and also for some hospitals.
Our hypothesis is that a number of relative inexpensive devices are now on the market that could be successfully employed to record videos or take still photographs during surgical, diagnostic and therapeutic procedures. The aim of this study is to report on the successful use of a commercially available head cam[a] for the recording of videos and pictures in different fields of veterinary medicine.

**Materials and Methods**
We tested a commercially available head cam[a] in a number of surgical and non-surgical procedures, both in hospital and in field settings. Testing was undertaken at the Department of Veterinary Sciences of the University of Turin.
During all procedures, the camera was positioned with the head strap on the clinician's head. Settings were as follows: 1080p and 30 fps, narrow field of view, Protune mode with white balance, and 12MP for photographs. An operator controlled the camera and the recording system with a tablet or smartphone using a free application[c] supplied by the manufacturer, along with a complete and practical video and photo editing software[d]. A remote control is available with the same functions and can be connected to the camera via Wi-Fi. Both videos and still photographs were recorded.
For all the described procedures an informed consent was obtained from the owner.
*Case 1:* donkey castration in field conditions. A 3-year-old donkey underwent surgical castration for excessive masculine behaviour. Anaesthesia was induced with ketamine

(2.2 mg/kg, IV ) and Diazepam (0.1 mg/kg , IV ) and maintained with a continuous rate infusion (IV) of guaphenesine (40 g), xilazine (500 mg), ketamine (150 mg) diluted in 500ml of saline. The donkey was positioned in dorsal recumbency. The surgeon stood between the hind limbs and performed a bilateral castration with a semi-closed technique.

*Case 2:* dog elbow luxation.

A 3 month-old, intact, mix-breed female dog was evaluated for non-weight bearing lameness of the left forelimb. Unilateral congenital elbow luxation was diagnosed radiographically. After induction of general anaesthesia and aseptic preparation of the limb, the congenital luxation was reduced manually. A stab incision was made on the caudal surface of the ulna and a transarticular, 1.4 K-wire was inserted. A transarticular linear external fixator was next applied. Reduction was achieved, even though a significantly decreased range of motion still persisted at one-month follow up.

*Case 3:* equine exploratory laparotomy. A 13 year-old, warm-blood gelding weighing 620 kg was referred to the Department of Veterinary Sciences, University of Turin, for a colic syndrome which had been lasting for 6 hours. At clinical examination, the likely cause was identified in a damage to the small intestine. Taking into account the relatively long duration of symptoms, and other approaches having failed, we opted for surgical correction. An entrapment of the small intestine in the epiploic foramen was detected, and an attempt was made to resolve it with resection and anastomosis. Three days postoperatively, the patient again manifested intractable signs of colic. At this stage, the owners asked for euthanasia and the horse was submitted for necropsy.

*Case 4:* equine limb wound. A 1-year-old trotter mare, weighing 400 kg was referred to the Department of Veterinary Sciences, University of Turin for an extensive wound on the left forelimb. The wound required immediate suturing to allow primary healing. The surgeon removed the necrotic tissues, applied a penrose drainage and finally sutured the wound in two layers. No post-surgical infection was detected and the horse was discharged three days later.

*Case 5:* equine joint injection. Joint injections are common practice during lameness examinations both in referring centres and in field conditions. A 5-year-old standardbred racehorse was examined for left hindlimb lameness. At clinical investigation, the horse was positive to flexion tests and showed swelling of the medial compartment of the femorotibial joint. Diagnostic anaesthesia of the joint was performed by intrarticular injection of 2% lidocaine. Radiographic examination was consistent with degenerative joint disease. The horse underwent arthroscopy the following day and was discharged two days later.

*Case 6:* bovine vulvar papilloma. A 3-year-old Holstein cow was examined for vulvar papilloma. Due to the large size of the papilloma and with the consent of the owner, the clinician opted for surgical excision. Surgery was carried out in a field setting, with the cow standing. After local anaesthesia (2% lidocaine ) an incision was made in the mucocutaneous junction, and the dissection was continued around the papilloma until it was released completely. Once the papilloma removed, the wound was closed in two layers with an absorbable suture material. At one-month follow-up, the mucosa had healed thoroughly without complications.

*Case 7:* A 4-month-old , Piedmontese cow was referred to the Department of Veterinary Sciences, University of Turin, for abdominal disease. A diagnosis of rumen impaction was made. Following administration of local anaesthetic (2% lidocaine) in an inverted L block, a 20cm vertical incision was made in the left flank, 4cm caudal and parallel to the last rib, and 6-8cm ventral to the transverse process of the lumbar vertebrae. The rumen was sutured to the skin with two nylon sutures in a simple continuous pattern.

An incision was made and the rumen was emptied. The incision was then closed in two layers with a simple continuous pattern oversewn with a cushing pattern. The abdominal wall was closed in three layers with absorbable suture using a simple continuous pattern. The skin layer was closed with non-absorbable suture using a simple continuous pattern. Three days after surgery, the cow recovered normal rumen activity and was fed a normal diet.

**Results:** The tested head camera[a] produced high-quality photographs and videos, with a good point of view, and allowed to reduce the number of people on the surgical field.

**Discussion**

Today, economic considerations and time constraints limit the availability of expert instruction in surgical simulations. In the absence of expert supervision, current training methods have come to rely ever so heavily on video instruction and self-practice, with seemingly good results[3-4]. Photographs and videos are also a tremendous help for case reporting, and sometimes for legal purposes too. The advantages of video-recording are indeed several-folds, ranging from detailed description of the surgical procedure and patient's clinical status, to improvement of routine manual operations such as infiltrations, and to anatomical description of body districts. These important aspects of veterinary training are hard to convey in writing, even when photographs and other visual media are included. Video- and photo-recording has some merit as an educational tool, provided it captures clear and sharp footage and offers good reproduction of the operator's point of view, while any intra-operative findings can be pointed out and explained.

A variety of video and photo-recording systems are currently available for medical use, the commonest being overhead mounted cameras and commercial video cameras. Overhead mounted cameras are attached to the operating room lights and are routinely used in many hospitals, while commercial video cameras can be either mounted on a tripod or operated by a dedicated person. The main problem with this type of equipment is that the surgeon's head and hands will likely block the view, while deep body cavities remain hard to capture on tape.

The tested head camera[a] allowed to overcome many of the limitations of conventionally used recording equipment. When it comes to large animals, reducing the number of people on the field becomes paramount because basic safety rules forbid having too many people approaching the patient in standing surgical procedures. The head camera[a] that we have tested it is particularly indicated in such cases because it does not require the presence of a dedicated operator, which is a massive advantage over other recording systems on the market. The same applies to hospital settings. During emergency procedures, patient management becomes the surgical team's primary concern, to the extent that having an extra person shooting videos over the surgeon's shoulder would be largely impractical, aside from any considerations related to increasing the risk of contamination of the surgical field.

In field castration, the whole procedure was recorded solely by the operating surgeon with no need for tripods or stands, as would have been the case with standard cameras. In performing medial femoro-patellar joint injection, the camera allowed to record images in a place that is normally difficult to see for observers without putting themselves or the surgeon in danger by standing too close to the horse.

In the operating room, a good reproduction of the surgeon's point of view was achieved in all procedures, with no heads/hands interference. Those present were able to observe the surgery in detail from a remote tablet connected via Wi-Fi while taking still photographs of key procedural steps. In field conditions, when removing a vulvar papilloma in a cow, a remote command was placed in a sterile glove, so that the surgeon

was able to start/stop recording and also to take still photographs without assistance. In performing the procedures the surgeon felt comfortable throughout, the camera being neither too heavy nor too bulky. Image and video quality was excellent and in some cases the device was able to capture views that could not have been obtained with other recording systems ( Figure 1 ).

Some drawbacks were observed in performing soft tissue surgery. An obvious issue was the flash effect created by the surgical lights reflecting on visceral surfaces, which resulted in excessive brightness. The point was partially addressed by using the Protune and white balance functions. Incidentally, this contrasts with what reported by Bizzotto[5] regarding the effective usefulness of the Protune mode in orthopaedic surgery. We also found the white balance feature essential in both orthopaedic and soft tissue surgery. By conveniently adjusting the white balance, we were able to correct the flash effect created by light reflection on the intestinal surface (Figure 2 ), and thereby eliminate the excessive brightness issue.

Unlike the camera[b] used by Matsumoto[6] the head camera[a] that we have tested it allows for control of the operator's view from a remote device, such as a tablet or smartphone, connected to the camera via Wi-Fi. Before surgery, the operator monitoring the procedure on tablet , smartphone or PC, can orient the camera so that it focuses in on the surgeon's hands, thus creating a perfectly congruent view. As mentioned above, the operator can also start/stop recording and take still photographs all along and, if any issues arise that affect image quality, these can be readily communicated to the surgeon. On top of that, the tested head camera[a] comes with a built-in function that allows to simultaneously capture both photos and videos. The camera shoots pictures at regular times while recording, without the need for a remote control. Again, this is a formidable option in field conditions.

Despite its manifold advantages, the head camera[a] that we have experienced it is far from being the perfect video-recording system. The main shortcoming is the absence of a zoom feature, a problem common with other systems as well[6] . We were able to in part address the issue by using the "NARROW" function, which allowed to get a closer view and focus in on the surgical field, with no need for video-editing. The second problem is related to the not-so-long duration of battery (1 hour). The authors suggest purchasing a supplementary, longer duration battery, currently available for sale. Another major limitation is related to head motion, which typically results in erratic, poor-quality shots. We did not experience such problem, possibly due to the surgeon being aware of the importance of keeping his/her head still and accordingly restricting motion, without influence on surgical procedures.

The head camera[a] that we have tested it is an effective, easy-to-use and relatively inexpensive device for recording surgeries and various veterinary procedures in all situations, both in hospital and in field settings. It provides excellent footage and image quality and in our view could be advantageously used for teaching, reporting and self-training purposes.

**Endnotes**

a. GoPro HERO3+ Black Edition , GoPro Inc. , San Matteo , California .
b. ContourHD 1080p Helmet Camera , Contour Inc. , Seattle , Washington .
c. GoPro app, GoPro Inc. , San Matteo , California.
d. GoPro studio , GoPro Inc. , San Matteo , California.

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**Figure legends**

Figure 1 : medial femoro-patellar joint injection

Figure 2 : abdominal cavity